

## BALL AND BEAM 1: Basics

Peter Wellstead: control-systems-principles.co.uk

**ABSTRACT:** This is one of a series of white papers on systems modelling, analysis and control, prepared by Control Systems Principles.co.uk to give insights into important principles and processes in control. In control systems there are a number of generic systems and methods which are encountered in all areas of industry and technology. These white papers aim to explain these important systems and methods in straightforward terms. The white papers describe what makes a particular type of system/method important, how it works and then demonstrates how to control it. The control demonstrations are performed using models of real systems that I designed, and which have been developed for manufacture by TQ Education and Training Ltd in their CE range of equipment. This white paper is about a very useful and influential laboratory system for teaching control of unstable systems – the Ball and Beam System.

### 1. What is the Ball and Beam?

The ball and beam system is one of the most enduringly popular and important laboratory models for teaching control systems engineering. The ball and beam system is widely used because it is very simple to understand as a system, and yet the control techniques that can be studied it cover many important classical and modern design methods. It has a very important property – it is open loop unstable.

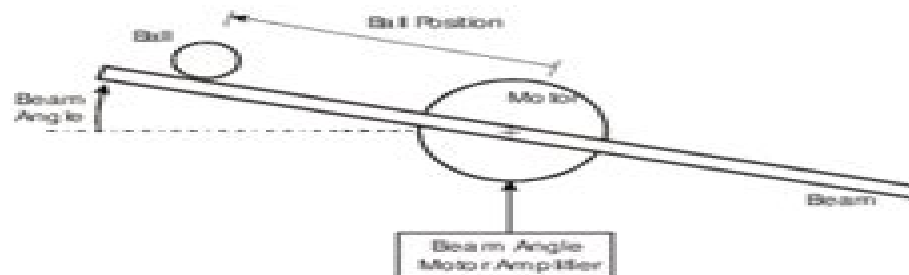


Figure 1. The Ball and Beam System.

The system (shown in figure 1) is very simple – a steel ball rolling on the top of a long beam. The beam is mounted on the output shaft of an electric motor and so the beam can be tilted about its centre axis by applying an electrical control signal to the motor amplifier. The position of the ball on the beam can be measured using a special sensor.

The control job is to automatically regulate the position of the ball on the beam by changing the angle of the beam. This is a difficult control task because the ball does not stay in one place on the beam but moves with an acceleration that is proportional to the tilt of the beam. In control technology the system is open loop unstable because the system output (the ball position) increases without limit for a fixed input (beam angle). Feedback control must be used to keep the ball in a desired position on the beam.

# Ball And Beam 1 Basics Control Systems Principles

**N Noddings**



## **Ball And Beam 1 Basics Control Systems Principles:**

**Advances in Control Education 1994** A. Ichikawa, K. Furuta, 2014-05-23 The implementation of effective control systems can help to achieve a wide range of benefits not least in terms of real cost savings Education plays a vital role in ensuring continued success and its importance is well recognized by IFAC with a specifically designated technical committee in this area This invaluable publication brings together the results of international research and experience in the latest control education techniques as presented at the most recent symposium Information on course curricula is presented as well as teachware including software and laboratory experimental apparatus

**Proceedings American Society for Engineering Education. Conference, 1994**

**JSME International Journal**, 2006

*Instrument Engineers' Handbook, Volume One* Bela G. Liptak, 2003-06-27 Unsurpassed in its coverage usability and authority since its first publication in 1969 the three volume Instrument Engineers Handbook continues to be the premier reference for instrument engineers around the world It helps users select and implement hundreds of measurement and control instruments and analytical devices and design the most cost effective process control systems that optimize production and maximize safety Now entering its fourth edition Volume 1 Process Measurement and Analysis is fully updated with increased emphasis on installation and maintenance consideration Its coverage is now fully globalized with product descriptions from manufacturers around the world

Bela G. Liptak speaks on Post Oil Energy Technology on the AT T Tech Channel

*Advanced Industrial Control Technology* Peng Zhang, 2010-08-26 Control engineering seeks to understand physical systems using mathematical modeling in terms of inputs outputs and various components with different behaviors It has an essential role in a wide range of control systems from household appliances to space flight This book provides an in depth view of the technologies that are implemented in most varieties of modern industrial control engineering A solid grounding is provided in traditional control techniques followed by detailed examination of modern control techniques such as real time distributed robotic embedded computer and wireless control technologies For each technology the book discusses its full profile from the field layer and the control layer to the operator layer It also includes all the interfaces in industrial control systems between controllers and systems between different layers and between operators and systems It not only describes the details of both real time operating systems and distributed operating systems but also provides coverage of the microprocessor boot code which other books lack In addition to working principles and operation mechanisms this book emphasizes the practical issues of components devices and hardware circuits giving the specification parameters install procedures calibration and configuration methodologies needed for engineers to put the theory into practice Documents all the key technologies of a wide range of industrial control systems Emphasizes practical application and methods alongside theory and principles An ideal reference for practicing engineers needing to further their understanding of the latest industrial control concepts and techniques

The Macmillan Guide to Correspondence Study Modoc Press, 1996

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    **Applied Mechanics Reviews** ,1954      **Mechanical Engineering** ,1920      *Journal of the Society of Automotive Engineers* ,1925 Vols 30 54 1932 46 issued in 2 separately paged sections General editorial section and a Transactions section Beginning in 1947 the Transactions section is continued as SAE quarterly transactions      **General Motors Engineering Journal** ,1955      **New Technical Books** New York Public Library,1977      *Municipal and County Engineering* ,1927      **Engineers' Digest** ,1979      **Society Records** American Society of Mechanical Engineers,1963

## Decoding **Ball And Beam 1 Basics Control Systems Principles**: Revealing the Captivating Potential of Verbal Expression

In a time characterized by interconnectedness and an insatiable thirst for knowledge, the captivating potential of verbal expression has emerged as a formidable force. Its ability to evoke sentiments, stimulate introspection, and incite profound transformations is genuinely awe-inspiring. Within the pages of "**Ball And Beam 1 Basics Control Systems Principles**," a mesmerizing literary creation penned by a celebrated wordsmith, readers embark on an enlightening odyssey, unraveling the intricate significance of language and its enduring impact on our lives. In this appraisal, we shall explore the book's central themes, evaluate its distinctive writing style, and gauge its pervasive influence on the hearts and minds of its readership.

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